Cognitive Errors in Emergency Radiology: A Literature-Based Review of Common Pitfalls and Practical Mitigation Strategies for Trainees

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BACKGROUND

- Diagnostic errors affect an estimated 3–5% of all radiologic interpretations — a persistent and underrecognized patient safety burden [1,2].
- Two major error categories recognized in literature:
  1. **Perceptual errors** — visible finding not detected → account for **60–80%** of all errors [1,3].
  2. **Cognitive/interpretive errors** — finding detected but wrongly interpreted → account for **20–40%** [1,4].
- **Cognitive biases** — systematic, often unconscious deviations in clinical judgment — are the primary driver of interpretive error [5,6].
- Dual-process theory explains the mechanism:
  1. *Type 1 (fast/heuristic):* efficient but error-prone under cognitive load.
  2. *Type 2 (slow/analytical):* effortful but more accurate — deliberate engagement reduces bias [7].
- **Radiology residents are uniquely vulnerable:**
  - -Limited experiential database → disproportionate reliance on heuristic shortcuts [4,8].
  - -High cognitive load, novel environments, and time pressure amplify bias susceptibility [8,12].
  - -Fatigue during overnight and extended shifts further compounds error risk [13,14].
- Recognizing bias types and their specific triggers is the **foundational step** toward building error-resilient diagnostic practice [1,7].

PURPOSE

- To systematically review cognitive and perceptual errors in emergency radiology
- To synthesize evidence-based mitigation strategies for radiology trainees

METHODS

- Narrative literature review of high-yield peer-reviewed papers on diagnostic errors in radiology
- Error taxonomy derived from established classifications in the literature
- Dual-process theory used to categorize errors and map mitigation opportunities
- Synthesis of error frequency, clinical impact, and trainee-focused strategies with emergency radiology focus

RESULTS

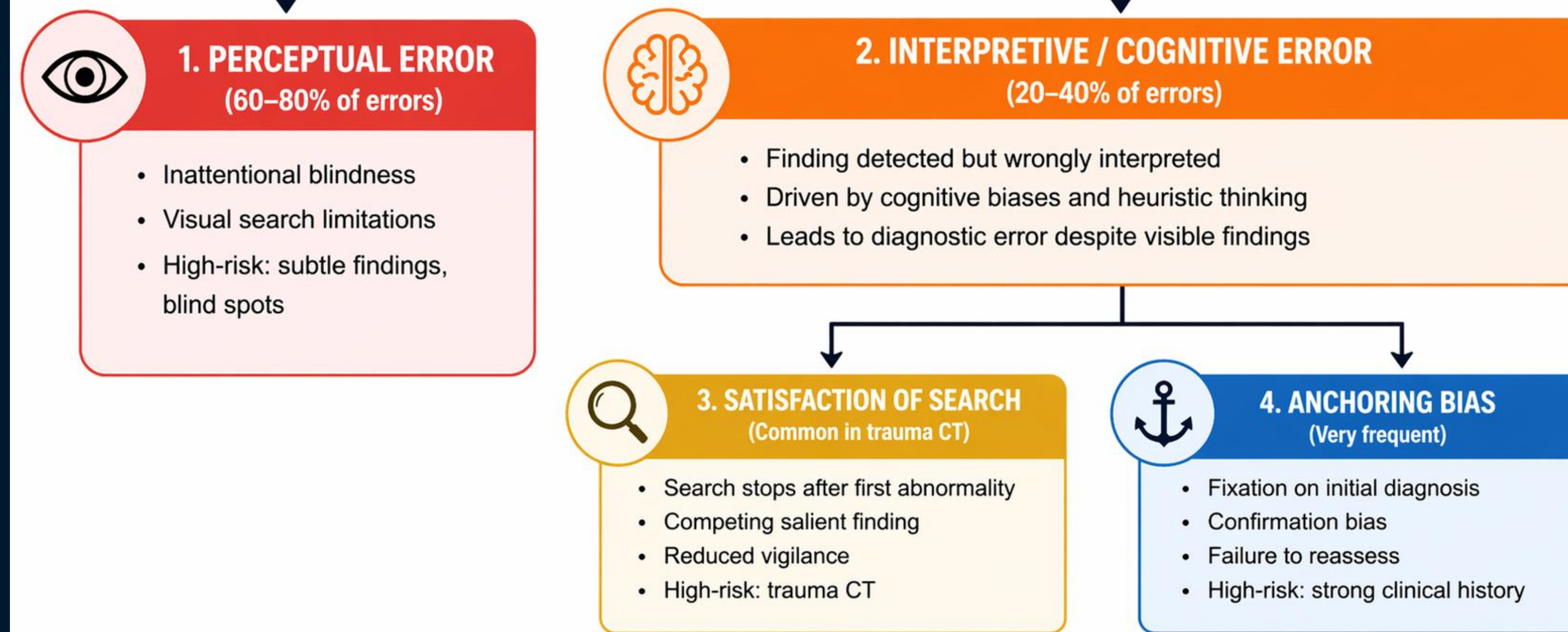

Figure 1. Hierarchical classification of diagnostic errors in radiology, illustrating the two major categories—perceptual errors (60–80%) and interpretive/cognitive errors (20–40%)—along with key subtypes including satisfaction of search and anchoring bias, and their underlying mechanisms.

REAL-WORLD EXAMPLES: COGNITIVE ERRORS IN ACTION

PERCEPTUAL ERROR — Missed subtle pneumothorax

Why? Study was CT abdomen/pelvis for abdominal pain – chest not adequately evaluated.

Fix: Always review the entire study. Don't let exam indication limit your search.

INTERPRETIVE ERROR — Liver hemangioma misinterpreted as tumor in pt with primary colon ca

Why? Peripheral discontinuous enhancement (hemangioma) mistaken for metastasis due to cancer history.

Fix: Correlate with classic imaging features and enhancement pattern. Avoid overcalling based on history.

SATISFACTION OF SEARCH — Second finding missed

Why? Focus on splenic laceration in trauma pt led to missing incidental renal mass.

Fix: After finding an abnormality, systematically review the entire study.

ANCHORING BIAS — Lymphoma appearing as pneumonia in pt with fever and cough

Why? Initial clinical impression of pneumonia led to premature closure and missed alternative diagnosis (lymphoma).

Fix: Keep a broad differential. Correlate imaging findings objectively, not just with initial impression.

Figure 2. Representative real-world imaging examples demonstrating common diagnostic error types: perceptual error (missed pneumothorax), interpretive error (hemangioma misdiagnosed as metastasis), satisfaction of search (missed secondary finding), and anchoring bias (lymphoma mistaken for pneumonia), with corresponding causes and corrective strategies.

COGNITIVE ERRORS IN PRACTICE: WHERE THINGS GO WRONG

ERROR TYPE	RESIDENT THOUGHT PROCESS (INCORRECT STEP)	REAL-TIME EXAMPLE
PERCEPTUAL ERROR	"Primarily an abdomen scan so nothing expected in the chest" → rapid scrolling / incomplete visual search	Subtle pneumothorax missed on CT performed for abdominal pain
INTERPRETIVE ERROR	"This must be malignancy given the relevant history" → over-reliance on clinical context	Liver hemangioma misinterpreted as metastasis in known cancer patient
SATISFACTION OF SEARCH	"Found the problem, less likely has anything else" → search prematurely terminated	Splenic laceration identified, incidental renal mass overlooked
ANCHORING BIAS	"This fits the clinical story" → no reassessment of alternatives	Lymphoma interpreted as pneumonia in febrile patient
FATIGUE-RELATED ERROR	"Looks okay, nothing much" → reduced vigilance due to workload	Missed subtle cervical spine fracture on overnight trauma CT

Figure 3. Common cognitive and perceptual errors in emergency radiology, illustrating typical flawed resident thought processes alongside real-world examples, including perceptual error, interpretive error, satisfaction of search, anchoring bias, and fatigue-related error.

MITIGATION STRATEGIES

5 RULES TO AVOID DIAGNOSTIC ERRORS

STEP	ERROR / BIAS ENCOUNTERED	RULE IN BRIEF
1	PERCEPTUAL ERROR	Use a systematic search pattern.
2	SATISFACTION OF SEARCH	Don't stop at the first finding; look for additional findings.
3	ANCHORING BIAS	Generate ≥2 differentials; challenge your first impression.
4	PREMATURE CLOSURE	Pause before final impression; think analytically (Type 2).
5	FATIGUE-RELATED ERROR	Recognize fatigue; take breaks and manage workload.

CONCLUSION

- Diagnostic errors in emergency radiology follow **recognizable, recurring patterns**
- **Perceptual and cognitive errors form the majority** of misses
- Real-world cases highlight the **clinical impact of these errors**
- Error types are **predictable and therefore targetable**
- Integrating cognitive awareness into training can **improve diagnostic performance**

REFERENCES | CONTACTS

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